SUPPLEMENTARY TABLE. Average weekly incidence* (October 3, 2021–December 24, 2022), mortality† (October 3, 2021–December 3, 2022), and rate ratios for unvaccinated compared with persons vaccinated with a booster dose by age, variant period,§ and time since receipt of last booster dose¶ — 23 jurisdictions, October 2021–December 2022**

Age group/ vaccine type/ interval since last booster dose	October 3–December 18, 2021 (Delta)			March 20–June 25, 2022 (Omicron BA.2)						September 18–December 24, 2022 (late Omicron BA.4/BA.5)					
	No.	Incidence	Rate Ratio (95% CI)††	No.	Incidence	Rate Ratio (95 % CI)††	No.	Incidence	Rate Ratio (95% CI)††	No.	Incidence	Rate Ratio (95% CI)††	No.	Incidence	Rate Ratio (95% CI)††
Cases															
All ages ≥12 years (age–standardized)															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	105,069	75.6	2.8 (2.5–3.1)
BV 3 mos	—	—	—	—	—	—	—	—	—	—	—	—	5,717	121.8	1.7 (1.2–2.4)
MV 2 wks–2 mos	45,969	60.7	7.0 (4.0–12.6)	1,013,495	349.1	3.4 (2.2–5.2)	112,316	94.8	2.4 (2.3–2.5)	112,215	150.0	2.8 (2.6–2.9)	15,616	75.6	2.8 (2.5–3.1)
MV 3–5 mos	3,391	106.5	4.9 (2.4–10.0)	339,278	239.3	5.0 (3.3–7.5)	532,048	173.6	1.3 (1.2–1.4)	181,552	181.6	2.3 (2.2–2.4)	94,737	103.2	2.0 (1.9–2.2)
MV 6–8 mos	—	—	—	2,458	62.0	2.4 (1.8–3.3)	392,970	272.5	0.8 (0.8–0.9)	583,512	212.7	1.9 (1.8–2.1)	105,553	108.1	1.9 (1.8–2.1)
MV 9–11 mos	—	—	—	—	—	—	8,300	241.0	1.4 (1.3–1.6)	211,593	181.5	2.3 (2.1–2.5)	329,018	111.0	1.9 (1.8–2.0)
MV ≥12 months	—	—	—	—	—	—	—	—	—	2,261	126.7	2.5 (2.2–2.9)	121,730	122.1	1.7 (1.6–1.8)
12–17 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	893	24.9	2.9 (1.9–4.4)
BV 3 mos	—	—	—	—	—	—	—	—	—	—	—	—	49	46.6	1.5 (0.8–3.0)
MV 2 wks–2 mos	—	—	—	7,821	94.6	5.0 (2.6–9.6)	4,593	61.7	1.5 (1.2–1.9)	1,938	67.3	2.9 (1.5–5.7)	449	36.8	2.0 (1.3–2.9)
MV 3–5 mos	—	—	—	302	145.1	3.3 (1.7–6.1)	20,224	159.7	0.6 (0.5–0.8)	6,543	103.5	1.9 (1.0–3.5)	1,651	45.3	1.6 (1.0–2.5)

MV 6–8 mos	—	—	—	11	41.0	1.8 (0.5–6.2)	600	141.0	0.7 (0.5–0.8)	13,201	115.5	1.7 (0.9–3.2)	4,150	57.2	1.3 (0.8–2.0)
MV 9–11 mos	—	—	—	—	—	—	36	104.7	1.2 (0.5–2.8)	184	69.9	2.8 (1.1–7.0)	5,578	49.8	1.4 (1.0–2.0)
18–49 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	25,419	78.9	1.9 (1.7–2.1)
BV 3 mos	—	—	—	—	—	—	—	—	—	—	—	—	1,667	133.0	1.1 (0.7-1.9)
MV 2 wks–2 mos	20,271	87.6	5.0 (2.4–10.2)	516,412	438.1	2.8 (1.5–5.2)	28,370	89.4	2.2 (2.0–2.4)	15,023	155.1	2.3 (2.1–2.4)	2,526	73.1	2.0 (1.7–2.4)
MV 3–5 mos	1,096	142.4	3.7 (1.4–9.6)	111,434	287.0	4.2 (2.2–8.0)	288,804	208.7	0.9 (0.9–1.0)	53,465	202.4	1.7 (1.6–1.9)	11,526	97.5	1.5 (1.4–1.7)
MV 6–8 mos	—	—	—	500	66.2	1.8 (1.1–2.9)	160,673	329.4	0.6 (0.5–0.7)	275,107	226.1	1.5 (1.4–1.7)	33,098	105.1	1.4 (1.3–1.6)
MV 9–11 mos	—	—	—	—	—	—	2,573	272.1	1.1 (0.9–1.3)	75,266	194.4	1.8 (1.6–2.0)	142,773	109.8	1.4 (1.2–1.5)
MV ≥12 mos	—	—	—	—	—	—	—	—	—	569	119.3	2.2 (1.8–2.6)	38,255	122.5	1.2 (1.1–1.4)
50–64 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	24,647	82.1	2.7 (2.5–3.0)
BV 3 mos	—	—	—	—	—	—	—	—	—	—	—	—	1,216	121.3	1.8 (1.2–2.8)
MV 2 wks–2 mos	10,476	41.3	11.2 (7.2–17.5)	280,390	314.7	3.9 (2.0–7.5)	30,792	112.3	2.2 (2.0–2.4)	36,506	169.5	2.5 (2.3–2.7)	4,907	84.2	2.6 (2.4–2.9)
MV 3–5 mos	931	94.3	6.1 (3.8–9.7)	81,814	201.1	6.1 (3.3–11.6)	137,083	139.9	1.7 (1.6–9)	46,104	173.9	2.4 (2.3–2.6)	27,630	117.6	1.9 (1.7–2.1)
MV 6–8 mos	—	—	—	579	60.3	2.7 (1.3–5.3)	99,111	242.0	1.0 (0.9–1.1)	161,628	218.3	1.9 (1.8–2.1)	26,612	114.4	2.0 (1.8–2.1)

MV 9–11 mos	—	—	—	—	—	—	1,982	224.1	1.6 (1.4–1.9)	50,497	188.7	2.3 (2.1–2.4)	93,495	123.4	1.8 (1.7–1.9)
MV ≥12 mos	—	—	—	—	—	—	—	—	—	579	141.6	2.2 (1.6–3.1)	30,969	142.8	1.6 (1.4–1.7)
65–79 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	36,801	83.0	6.1 (5.4–6.9)
BV 3 mos	—	—	—	—	—	—	—	—	—	—	—	—	2,068	120.2	4.2 (2.8–6.4)
MV 2 wks–2 mos	11,455	25.0	28.9 (20.9–39.9)	161,805	234.5	7.3 (3.9–13.4)	36,809	114.2	3.8 (3.5–4.2)	41,913	154.0	5.3 (4.9–5.8)	5,267	87.8	5.8 (5.1–6.5)
MV 3–5 mos	1,110	64.3	13.6 (8.9–20.8)	111,798	172.7	9.9 (5.9–16.4)	64,409	90.0	4.8 (4.4–5.3)	54,454	155.5	5.3 (5.0–5.6)	34,780	123.4	4.1 (3.7–4.6)
MV 6–8 mos	—	—	—	1,036	61.3	5.4 (3.4–8.5)	97,275	179.5	2.4 (2.2–2.6)	100,057	211.5	3.9 (3.7–4.1)	27,406	124.1	4.1 (3.7–4.5)
MV 9–11 mos	—	—	—	—	—	—	2,810	232.5	2.8 (2.5–3.1)	61,401	187.9	4.4 (4.1–4.6)	61,596	126.8	4.0 (3.6–4.4)
MV ≥12 mos	—	—	—	—	—	—	—	—	—	827	159.6	4.0 (3.7–4.3)	35,196	143.0	3.5 (3.2–3.9)
≥80 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	17,309	130.6	4.1 (3.5–4.8)
BV 3 mos	—	—	—	—	—	—	—	—	—	—	—	—	717	164.7	3.3 (2.0–5.3)
MV 2 wks–2 mos	3,767	27.3	16.6 (13.2–20.9)	47,067	235.6	5.0 (2.9–8.6)	11,752	123.2	2.9 (2.6–3.3)	16,835	193.3	3.5 (3.3–3.8)	2,467	136.3	3.9 (3.3–4.7)
MV 3–5 mos	254	52.3	10.7 (8.4–13.7)	33,930	173.4	6.7 (4.4–10.3)	21,528	104.9	3.4 (3.0–3.9)	20,986	199.4	3.4 (3.2–3.6)	19,150	210.6	2.5 (2.2–3.0)
MV 6–8 mos	—	—	—	332	67.9	4.1 (2.5–6.7)	35,311	213.0	1.7 (1.5–1.9)	33,519	254.6	2.7 (2.5–2.8)	14,287	209.4	2.6 (2.2–2.9)

MV 9–11 mos	—	—	—	—	—	—	899	257.4	2.0 (1.8–2.4)	24,245	240.0	2.8 (2.6–3.0)	25,576	185.6	2.9 (2.5–3.3)
MV ≥12 mos	—	—	—	—	—	—	—	—	—	270	181.0	3.0 (2.5–3.7)	17,234	214.3	2.5 (2.2–2.9)
Deaths by age group and time since vaccination															
All ages ≥12 years (age–standardized)															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	220	0.1	15.2 (11.3–20.3)
MV 2 wks–2 mos	580	0.2	50.7 (32.8–78.3)	3,136	0.7	21.4 (16.8–27.3)	361	0.2	7.9 (5.5–11.4)	655	0.4	7.4 (5.2–10.7)	109	0.3	6.5 (4.2–10.1)
MV 3–5 mos	61	0.7	20.1 (12.0–33.6)	2,609	0.7	22.1 (17.4–28.1)	886	0.2	7.5 (5.8–9.8)	797	0.4	7.2 (5.6–9.3)	555	0.4	5.0 (3.5–7.0)
MV 6–8 mos	—	—	—	54	0.6	9.1 (4.7–17.7)	1,380	0.4	3.6 (2.9–4.4)	1,803	0.6	4.6 (3.9–5.5)	360	0.3	5.4 (4.5–6.5)
MV 9–11 mos	—	—	—	—	—	—	48	0.7	2.7 (1.7–4.2)	1,323	0.6	4.5 (3.7–5.5)	981	0.4	5.1 (4.4–6.0)
MV ≥12 months	—	—	—	—	—	—	—	—	—	32	1.0	2.5 (0.9–6.7)	387	0.4	4.7 (3.3–6.8)
12–17 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	0	0	—
MV 2 wks–2 mos	—	—	—	0	0	—	0	0	—	0	0	—	0	0	—
MV 3–5 mos	—	—	—	0	0	—	0	0	—	0	0	—	0	0	—
MV 6–8 mos	—	—	—	0	0	—	0	0	—	0	0	—	0	0	—
MV 9–11 mos	—	—	—	—	—	—	0	0	—	0	0	—	0	0	—
18–49 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	1	0.01	14.6 (9.1–23.4)
MV 2 wks–2 mos	9	0.05	29.8 (2.5–355.6)	58	0.1	16.8 (11.1–25.4)	4	0.02	6.1 (0.6–61.5)	5	0.1	2.6 (0.1–54.3)	0	0	—
MV 3–5 mos	1	0.1	10.0 (0.3–353.9)	38	0.1	8.9 (3.9–20.1	16	0.01	6.8 (1.7–26.9)	16	0.1	2.1 (0.4–10.1)	7	0.1	1.0 (0.1–12.0)

						)									
MV 6–8 mos	—	—	—	0	0	—	22	0.1	1.8 (0.4–9.4)	52	0.1	3.0 (1.4–6.4)	6	0.03	3.0 (0.4–20.9)
MV 9–11 mos	—	—	—	—	—	—	2	0.2	0.5 (0.1–2.1)	19	0.1	2.7 (0.6–11.8)	14	0.02	5.2 (1.3–20.3)
MV ≥12 mos	—	—	—	—	—	—	—	—	—	1	0.2	0.6 (0.003–139.8)	3	0.02	3.6 (0.001–12,191.5)
50–64 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	9	0.1	13.8 (2.3–83.9)
MV 2 wks–2 mos	70	0.3	36.5 (11.7–113.6)	338	0.5	24.3 (15.2–38.7)	34	0.2	5.3 (1.4–19.7)	32	0.2	8.7 (3.0–25.2)	12	0.2	3.2 (0.7–15.1)
MV 3–5 mos	13	1.5	9.3 (4.7–18.7)	247	0.7	15.8 (7.3–34.2)	97	0.1	6.6 (3.2–13.8)	50	0.2	6.5 (2.8–15.1)	34	0.2	3.9 (1.6–9.6)
MV 6–8 mos	—	—	—	9	1.0	3.4 (1.4–81)	90	0.3	3.1 (1.6–6.0)	181	0.3	4.9 (2.8–8.6)	27	0.2	4.3 (1.9–10.0)
MV 9–11 mos	—	—	—		—	—	7	0.9	1.1 (0.6–2.1)	88	0.4	3.8 (1.7–8.7)	95	0.2	4.2 (2.0–8.7)
MV ≥12 mos	—	—	—		—	—	—	—	—	2	0.5	2.6 (0.02–430.4)	20	0.2	3.6 (0.5–23.5)
65–79 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	71	0.3	25.4 (14.8–43.6)
MV 2 wks–2 mos	267	0.7	81.5 (53.2–124.8)	1,104	1.9	36.9 (26.6–51.2)	116	0.4	13.8 (8.4–22.9)	186	0.8	14.2 (8.8–22.7)	36	0.7	10.2 (3.4–31.0)
MV 3–5 mos	29	1.9	35.9 (23.1–55.7)	1,113	2.0	35.5 (25.0–50.4)	278	0.5	12.7 (8.3–19.4)	285	1.0	11.5 (7.4–17.9)	156	0.7	10.0 (6.6–15.2)
MV 6–8 mos	—	—	—	27	1.8	12.9 (4.1–	388	0.8	7.1 (5.2–9.7)	596	1.5	7.3 (5.3–10.2)	124	0.9	8.3 (5.7–11.9)

						40.1)									
MV 9–11 mos	—	—	—	—	—	—	19	1.7	4.4 (1.4–14.3)	508	1.8	6.2 (5.0–7.7)	320	0.9	8.0 (5.7–11.3)
MV ≥12 mos	—	—	—	—	—	—	—	—	—	14	3.0	3.3 (0.9–12.0)	132	1.0	6.9 (4.9–9.8)
≥80 years															
BV 2 wks–2 mos	—	—	—	—	—	—	—	—	—	—	—	—	139	1.9	11.2 (8.0–15.5)
MV 2 wks–2 mos	234	2.0	38.5 (24.1–61.5)	1,636	10.0	12.9 (8.5–19.6)	207	2.6	6.1 (3.9–9.5)	432	5.8	5.4 (3.8–7.7)	61	4.0	5.3 (3.6–7.7)
MV 3–5 mos	18	4.3	21.8 (10.8–43.8)	1,211	7.3	17.6 (12.5–24.9)	495	2.9	5.5 (3.9–7.7)	446	5.1	6.1 (4.8–7.7)	358	5.1	4.1 (3.4–4.8)
MV 6–8 mos	—	—	—	18	4.2	10.2 (2.5–41.9)	880	6.2	2.6 (2.1–3.1)	974	9.0	3.5 (2.7–4.4)	203	4.8	4.4 (3.6–5.3)
MV 9–11 mos	—	—	—	—	—	—	20	6.4	3.5 (2.1–5.7)	708	8.2	3.9 (2.9–5.1)	552	5.3	3.9 (3.3–4.6)
MV ≥12 mos	—	—	—	—	—	—	—	—	—	15	11.3	2.4 (1.2–4.9)	232	5.5	3.8 (3.0–4.8)

Abbreviations: BV = Bivalent booster; MV = Monovalent booster; "—" = not applicable/calculated.

* Cases per 100,000 persons aged ≥12 years. COVID-19 cases among unvaccinated persons and persons vaccinated with a primary series with or without a monovalent or bivalent booster dose were defined as previously described (https://www.cdc.gov/coronavirus/2019-ncov/php/hd-breakthrough.). Cases were excluded in persons who only completed a primary series or who received at least one FDA-authorized vaccine dose but did not complete a primary series ≥14 days prior to the positive specimen collection date.

† Deaths per 100,000 persons aged ≥12 years. A COVID–19–associated death occurred in a person with a documented COVID–19 diagnosis who died, and whose report local health authorities reviewed (e.g., using vital records, public health investigation, or other data sources)–make that determination. Per national guidance, this group includes persons whose death certificate lists COVID–19 disease or SARS–CoV–2 as an underlying cause of death or as a significant condition contributing–death. COVID-19 mortality by vaccination status is reported based on COVID-19 test date, not the date the patient died.

§ Analysis periods were categorized based on variant predominance (defined as >50%): Delta, October 3–December 18, 2021; Omicron BA.1, December 19, 2021–March 19, 2022; Omicron BA.2, March 20–June 25, 2022; early Omicron BA.4/BA.5, June 26–September 17, 2022; late Omicron BA.4/BA.5 (only period where BV boosters were recommended), September 18–December 24, 2022

¶ Time since last monovalent booster categories were restricted to outcomes occurring during eligible weeks based on the timing of the first booster recommendation for adults ≥65 years and adults ages ≥18 years in high–risk groups on September 24, 2021: 2 weeks–2 months (starting October 3, 2021); 3–5 months (starting November 13, 2021); 6–8 months (starting February 13, 2022); 9–11 months (starting May 15, 2022); ≥12 months (starting August 14, 2022). For people ages 12–17 years, boosters were recommended

for all on January 5, 2022; data are included the week starting January 16, 2022. Bivalent boosters were included for the period starting September 18, 2022, and for categories of 2 weeks–2 months and 3–5 months after receipt of a booster for cases and 2 weeks–2 months after receipt of a booster for deaths. Unvaccinated persons are compared to vaccinated persons for the same time frame in each category. The median interval in the 2 weeks–2 months since vaccination period was longer for persons with monovalent boosters during early (60 days) and late (70 days) BA.4/BA.5 periods than for those who received bivalent boosters (47 days). The median interval among persons who received a monovalent booster 3–5 months earlier was 131 and 144 days, respectively, during early and late BA.4/BA.5 periods; among those who received bivalent boosters 3–5 months earlier, the median interval was 95 days.

** These 23 states represent 50% of the overall U.S. population and were included in this analysis: Alabama, Arkansas, Arizona, Colorado, District of Columbia, Georgia, Idaho, Indiana, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Nebraska, New Jersey, New Mexico, New York, North Carolina, Tennessee, Texas, Utah, Washington, West Virginia; New York did not provide mortality data.

†† 95% CIs calculated after detrending underlying linear changes in weekly rates using piecewise linear regression. Each 95% CI represents the remaining variation in observed weekly rates and resulting rate ratios. The number of observations informing each 95% CI reflects the number of weeks per period: Delta (11), Omicron BA.1 (13), Omicron BA.2 (14), early Omicron BA.4/BA.5 (12), and late Omicron BA.4/BA.5 (14).